Exploiting the internet to improve collaboration between users and design team.

The case of the new Computer Laboratory at the University of Cambridge

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Abstract: Cambridge University and Microsoft are building a shared computer research and teaching laboratory on a green-field site to the west of the city. The clients wished to use internet based communication between themselves and their architects, including email, a web site and virtual reality. We explain how this is to be achieved, and describe experiences during the first six months of a two year project. Particularly successful has been the use of games software (Quake II) for 3d presentation of the emerging building design.

1. INTRODUCTION

Cambridge is an ancient University, squeezed into a small market town which even now has only 120,000 inhabitants. Until 100 years ago, the colleges and University buildings were all to be found within five minutes walk of the market place. Then, as the sciences began to assume their present importance there came an explosion in University building but still in, or immediately adjacent to, the historic centre. The original Botanic Garden was displaced a mile southward, and the site occupied by the Cavendish Laboratory. Downing College sold an undeveloped part of its site, and the combined area was rapidly covered with new science buildings - museums, libraries, teaching laboratories and research spaces. The development pressure was phenomenal: within fifty years the originally gracious layout of courtyards was choked by a sediment of infill buildings, animal houses, gas stores, bicycle sheds, and “temporary” huts crammed into the courtyards, on rooftops, anywhere. By the 1950’s the pressure became intolerable and significant new developments were made further away - Chemistry to the south, and Veterinary Medicine pioneering in farmland a mile away to the west.

Less fortunate were the Computer Laboratory and Zoology Department, which were rehoused in situ, in a fragment of a megastructure known as the ‘Arup Tower’. This was intended by the planners to be the first stage in a Buchanan inspired redevelopment of the city centre, with pedestrian circulation segregated to a high level system of decks and bridges. Only one other piece of this pattern was ever built - the courthouse on top of a car park across the street - but the bridges never appeared, and so the new building eventually came to be seen, like the skeleton prominently displayed in the Zoological part of its podium, as a beached whale.

The Cavendish Laboratory followed the Vets to the West, as did a scattering of other technological departments, and hi-tech businesses - including Schlumberger whose ‘tent’ (Hopkinson and Happold 1985) is the most distinguished building there. The building of the M11 motorway bypassing Cambridge to the West gave the site a definite boundary and identity and it became the long term strategy of the University to gradually decant the science and technology faculties, as they outwore their central buildings, to this largely vacant site.

A masterplan for this ‘West Cambridge’ site was drawn up by MacCormac Jamieson Prichard, presented to the University in 1997, and is currently being reviewed by the city planners. It shows the site, which extends from the western suburbs of Cambridge to the motorway, bounded on the north by the Bedford road, and to the south by the ‘Coton footpath’; long used by academics as a place of recreation, but in fact the remnant of a still navigable medieval trackway connecting Cambridge to the villages of the west - Coton, Hardwick, Toft, Bourn. The plan shows a mix of high-tech industries along the north, accessed from the road, and University buildings to the south, reached on foot or by bicycle, from a covered ‘colonnade’ along the line of the Coton footpath. A central ‘forum’ is surrounded by shared large lecture halls, refectory, sports centre and other shared facilities.

Meanwhile the Computer Lab had expanded into parts of the old Cavendish, connected by a bridge at third floor level. By the 1990s the building was out of date and overcrowded. When the opportunity to rebuild arose, it was eagerly accepted by the University.

The proposed new Computer Laboratory is an interesting and complex project, which fits very well with the spirit of the masterplan. Funded partly by a donation from the William Gates III foundation, part of its floor space is to be leased on commercial terms to Microsoft for use as its major European research laboratory. It is the first building to be designed since the masterplan was published, and so is on the eastern edge nearest the city. As a mixed-use building it is on neither the northern road access, not the southern cycle way, but half way in-between.

1.1 Architectural expectations

Our first contact with the Computer Laboratory occurred in mid 97. At this point they had completed a written brief and were searching for an architect. The brief made some unusual demands of the architect:

> "The Laboratory and its principal benefactor are extremely enthusiastic about the use of computer modelling in the design and visualisation of the new building. This will have a number of benefits, including assisting the fund raising efforts of the Laboratory, allowing the Laboratory's members to gain an understanding of the design before it is realised, and publicly demonstrating the Laboratory's commitment to the use of computer oriented design techniques"

> "The appointed architect is expected to use 3D computer modelling as an integrated part of the design process. The data should be transferable to the Computer Laboratory in an agreed standard format, to enable our staff and students also to perform their own walkthrough and other experiments. Communication between the architect and the Laboratory should be by email, and also via a web site for the exchange of models and designs."

Aware that thorough-going 3D design was quite unusual in architecture, we replied that it was reasonable to ask the architect to use computer presentations, but design tools were personal to an architect, and should not be dictated by a client. Better choose an architect who can produce a good building, than one using a preconceived methodology.

The brief ended alarmingly:

> "It is crucial that an excessive burden is not placed on the academic staff of the Laboratory through meetings, requests for information etc. Information exchange via email could assist in achieving this. It is expected that those academic staff liasing with the architects should each average at most two hours a week on work related to the building"

This touched a nerve. Despite the endeavours of its building professionals, Cambridge University has a gift for getting bad buildings out of good architects - Stirling's disastrous History Faculty Library being the best known. Architects find the University and Colleges difficult and frustrating clients because they are faced, not with an enthusiastic client with whom they can build a personal relationship, but with a building committee, consisting of academics who are not really interested in what is going on, attend irregularly, and regard the whole operation as an irksome chore. At the end of a long campaign, the project architect may find himself the only person who has served continuously. This structure does not lend itself to responsible, consistent decision making.

There followed quite a lengthy email debate; our suggestion of the need for a more committed style of project management being countered by an enthusiasm for a 'standard box' of a building, which would minimise design risk and the need for consultation, and a horror of award-winning architects and award-winning buildings (the disliked Arup's Tower had won an RIBA Bronze Medal) .

The concern that the architect should be fully computerised was significant during the short-listing phase - for example one well-known name was rejected -

> ".. as a practice, they were not sufficiently wired. Incredibly, although all architects have workstations, email is not used inside the company at all, and email from clients has to go to a single address that is then processed by a secretary. We did not feel we could work with them."

In the end a limited competition was held. Most firms presented their proposals as HTML pages - which served chiefly to demonstrate that GIF is a hopeless way of presenting architectural plans. Some did a little animation or VRML. But good sense prevailed, and the winning architect – RMJM – was one who could demonstrate a workmanlike process, had built comparable buildings successfully, and (to our relief) could field a project architect to whom the head of the Laboratory took a strong personal liking.

Their use of CAD was quite normal and standard - the bulk of the design work is done in 2d on AutoCAD, with 3d Studio Max used for presentation. Workstations are less than 'one-per-desk', CAD is in the hands of specialists, and email though present, is not ubiquitous.

As it became apparent to the Computer Lab that the kind of intense electronic communication that the brief envisaged was not normal architectural practice (and perhaps more significant to the University authorities, could not be achieved without a fee uplift), they began to see it as a research opportunity, and asked us for proposals.

We had to move quickly, as the preliminary design was already underway. Fortunately, the project readily gripped the imagination of several industrial sponsors, who offered hardware and software contributions, and the EPSRC, who agreed to give accelerated consideration to an application for the staff costs. Getting agreement among the participants was rather more delicate (as will be discussed below). In addition to the Computer Laboratory and the architects RMJM, these now included Microsoft Research Ltd, Microsoft's facilities consultants, the University's Estate Management and Building Services (EMBS) division, who are the legal client, and a cost consultant.

1.2 The building

The brief asks for 10,000 m^2 of floor space. The total project budget is £20m, of which £12m is for the building, the rest being for equipment and relocation. As well as the embedded Microsoft laboratory, the building is to contain teaching space for several hundred undergraduate and graduate students, a library, machine rooms, research laboratories and a cafeteria. A central problem is to get the right degree of contact and separation between the three main categories of occupants - undergraduates, postgraduates and academic/research staff. The embedded laboratory is to preserve its separate identity, but facilitate interaction, both organised and accidental. The circulation space is to promote meetings and discussion "with chairs in cosy nooks and crannies .. lots of whiteboards scattered in public places .. public terminals .. cybercafe area." The building is expected to be environmentally friendly, with a minimum of air-conditioning “lots of natural light, openable windows and a nice view” while avoiding the overheating that has plagued some recent buildings. Technological requirements centre on the need to accommodate an intensive and ever-changing computer network. Amenities should include new cycle paths, cycle storage and showers, and “some kind of common room where the current tradition of morning coffee and afternoon tea for the whole Laboratory can be continued.”

1.3 Research objectives

Our formal objective is to find ways of using the internet to achieve better buildings, by improving the consultation process between architect and eventual user. This means we need to engage people’s interest in the project, keep them informed, facilitate discussion, and channel feedback to the architect.

The future occupants of this building - that is the staff and students of the Computing Laboratory, and the researchers employed by Microsoft - are ideal subject matter as they combine a high proficiency in electronic communication, with an unflattering opinion of architects and architecture. They see the first as a way of reducing the nuisance of having to deal with the second. Our project will succeed if it can use technological enthusiasm to seduce the computer scientists into a constructive relationship with the architectural project.

The first intention is to build a web server to provide on-line access to a comprehensive library of design information, linked to a bulletin board for gathering feedback. The second is to monitor the effectiveness of such as system, and study how it is used in practice to improve communication between client and design team.

Much of the material is expected to originate with the architects, using their in-house CAD systems (3D Studio Max and AutoCAD), but will need to be translated, extended, simplified, edited and interlinked to form a web library. Keeping the links working in the face of constant revision is likely to be a substantial problem.

The provision of 3d walkthrough we anticipated would be met in the early stages by generating VRML from 3D Studio, and later by bringing into play a viewer for very large models (million polygons upwards) which is the result of an earlier Martin Centre research project, and currently under commercial development.

Effectiveness is to be measured by regular web-based questionnaires. These will investigate changing perceptions of both the building, and the web-site.

2. PROGRESS

The project was eventually funded and started in July 1998, about six months after the architectural competition, so our immediate need was to catch up with progress already made. As it was also our first substantial web-based project, and our first research project to be based on Windows/NT, there was a somewhat steep learning curve to be climbed. We discovered that the Computer Laboratory, while fully wired, was largely using Linux on PCs, with Solaris on Suns, and deployed a variety of not quite fresh versions of Netscape. Even Lynx had some currency. On the other hand, the Microsoft end of our user-base would be using NT on Intel and the latest version of Internet Explorer.

This context argued for a very straightforward initial design for the site, avoiding even such mild elaborations as frames. It also became apparent that there were two levels to the project - the building and the site, as represented by the masterplan. The enjoyment of the Computer Laboratory would be substantially affected by progress (or the lack of it) on other parts of the site. Some issues that are mentioned in the brief - such as cycle ways - are outside RMJM's control, as they belong to the masterplan. Though responsibility is divided, both are important. So we conceived of two web-sites, an outer one presenting the masterplan and brief information as it became available on individual buildings, forming a context for the inner one, which would deal in great detail with the Computer Laboratory building itself. The outer site, we envisage, may last much longer than the inner, as the masterplan is likely to take 25 years to complete. It is also relevant to a much wider community than the inner.

The two sites achieve unity by using a similar style of header and footer on all pages, differentiated by a slight difference in colouring. The same design principles apply to each site: a straightforward tree structure - home page plus two levels of index to reach the content pages, page length restricted to a couple of screens full, sparing use of cross and off-site links. The pages were initially made fixed width (by use of tables), but freed after adverse comment from the Computer Lab. The consequence is that the fixed-width page headers and footers now look a little silly, and will have to be replaced at some time with navigational side-bars.

2.1 Outer site

This site was implemented second, largely using material from MacCormac's masterplan, and did not become live until February 1999. However, it is best discussed first, as it sets the context for the Computer Laboratory building.

*Figure 1.*West Cambridge in 1743

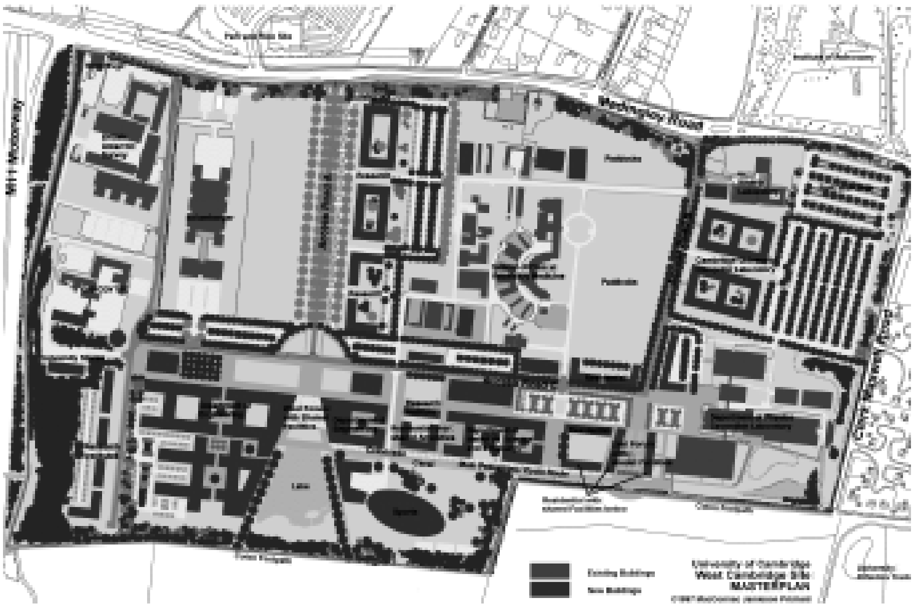

Figure 2. Masterplan used as entry image map to the outer site

The contents page shows a simplified version of the masterplan as an image map (Fig 2). Buildings and features under the cursor identify themselves, and clicking will (eventually) take you to the appropriate inner site. Also accessible from this page are:

- **Proposal** - full text of MacCormac's proposals for the site
- **Summary** - a non-technical summary of the official proposal
- **Diagram** - a variety of downloadable version of the site plan
- **Maps** - plan-form contextual material collected by ourselves. Most revealing are the aerial photographs (on which the masterplan and car and cycle access routes can be superimposed), which clearly show the scale of the site (larger than the historic core of Cambridge) and its distance from current University facilities.
- **Views** - site photography and other scenography, including an old print showing the skyline of Cambridge as seen from the West in 1743 (Fig 1). A large part of this view survives, and is seen as providing an essential visual connection between the new site and the historic centre.
- **Diary** - history of events affecting the western development of Cambridge.

Figure 3. Aerial photograph with masterplan superimposed, and cycle route indicated. Demonstrates the size of the West site compared to the ancient city, and its relative isolation

2.2 Inner site

This page gives access to all the consultation drawings issued by the architects, and a variety of background documents.

2.2.1 Project Documentation

Textual information, starting with the original competition brief, and the quantified brief produced by RMJM in the early months of the project. This will eventually expand to full "room data" description of the building, giving usage, floor area, equipment, servicing needs and so on, for every room. Additional textual information, such as meeting notes and specialised reports, will be placed here.

2.2.2 Building proposals

Goes to an index of each major revision of the drawings. Each revision is represented by a page forming an index to all the drawings and models available.

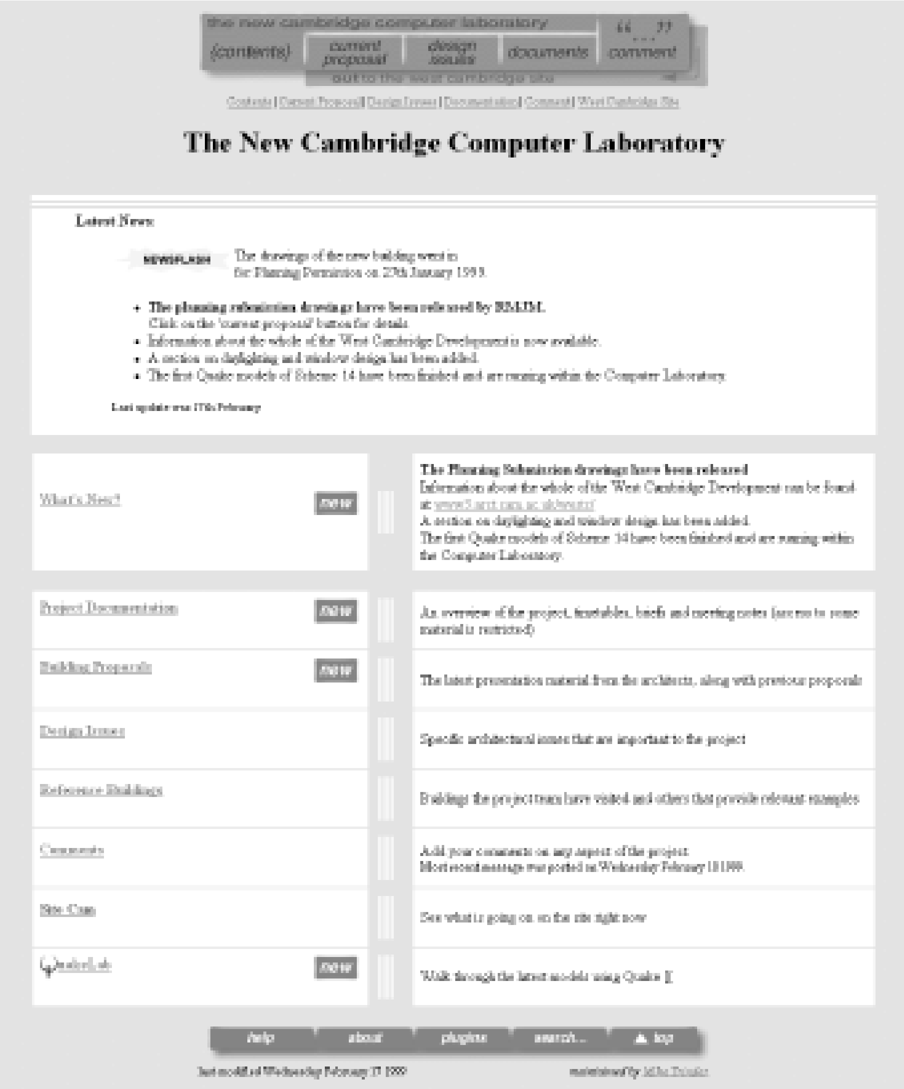

Figure 4. Contents page, inner site

2.2.3 Design issues

Essays prepared by ourselves to clarify architectural issues that have arisen in the discussion groups, and generally drawing on other areas of research in the Martin Centre. For example, the earliest proposals from RMJM addressed the ‘environmentally friendly’ requirements of the brief by employing a shallow plan form, E-W orientation, and night-cooled hollow plank floors. We contributed a paper on green architecture, explaining the general principles behind these and other practical approaches to low-energy building in the British climate. Later a discussion developed around suitable widths for corridors, which we supplemented by posting photographs of measured widths in the existing building. Recently quite a passionate discussion has developed about daylight and views. One of our research students, who is finishing a PhD on subjective reactions to daylight, contributed an essay on the topic, with background information from a forthcoming book on daylight being written by two colleagues.

2.2.4 Reference buildings

Initially we intended this page for buildings visited by the design team, or used by RMJM as references. Later we discovered that Bill Gates is supporting a number of parallel projects in American universities, and that they have web-sites in some degree parallel to ours, so we extended the section to provide links to web-sites related to interesting Computer Laboratories.

2.2.5 Comments

Each page has a comment button, which leads to a web-based bulletin board. This uses a slightly modified version of a standard Perl script WebBBS. One modification is to capture the identity of the page on which the comment button was pressed, with the idea of using this information later to analyse the relative impact of different documents.

The presentation of the BBS is conventional, with messages viewable in date or inverse thread order.

2.2.6 Site Cam

When construction starts, this will link to video camera views from one or two adjacent buildings. The London-based architects are looking forward with relish to the possibility of seeing what is going on on-site, whenever they wish.

2.2.7 Quake Lab

Links to the virtual reality pages described below.

2.3 Formats

Scanned material and computer renderings are normally posted as JPEG images, in a choice of resolutions, and are straightforward. More problematical is the presentation of CAD drawings originating in AutoCAD (for the building) or Microstation (for the masterplan). The predominance of Linux at the Computer Lab means that the many of the standard plugins are not available, and that Java based extensions have to be sought.

AutoCAD drawings were initially posted in the DWF format, together with a Java reader called CADViewer Light from Arnona (www.cadview.com). Even this failed initially, as some instances of Netscape at the Computer Lab were too old to run Java successfully. A forced upgrade to Netscape 4.5, courtesy of the Computer

Lab sysops, fixed the problem. The freeware version of CADViewer provides reasonable performance in panning and zooming (thought not as lively as the WHIP plugin available on NT), but does not allow printing, which almost immediately became a problem. The solution was to convert the AutoCAD material to the Adobe Acrobat PDF format, which is available on all platforms, and seems entirely suitable, at least for drawings of the complexity we have encountered so far. The black-on-white format is preferable to the vivid colour-on-black that you get from DWF; proper fonts come naturally, panning and zooming on screen is easy, and drawings are easily printed at a definite scale.

Generating PDFs is not so easy, and we have yet to establish a foolproof workflow. In principle you open the DWG in an amenable CAD system (we have been using microGDS), and print it at the required scale to a postscript printer, checking the ‘print to file’ box. The postscript file can then be processed through the Acrobat Distiller, to generate PDF. The main difficulty is that most CAD systems seem to require you to have a driver and physical plotter on your network of the size required of the PDF image, before you can generate a postscript file.

We use a similar route out of Microstation, with a detour through Adobe Illustrator to tune up labelling, fonts and fills. To make an image map we then export as EPSF and render to GIF in PhotoShop. We have used video formats such as QuickTime and animated GIF to a limited extent to display moving images, such as sun studies. With interactive controls, it is easy to see how the pattern of sunlight and shadow varies with the time of day, and season of the year.

Apple’s QTVR has long impressed us as an ideal web format for architectural presentation. The PC equivalent, LivePicture, has been used by RMJM to extraordinarily good effect. Their method is to construct an outline geometrical model in 3D Studio, and render it as a LivePicture panorama. The cylindrical texture map is printed, and used as a guide for hand drawing the interior architecture, which is then scanned, coloured, and substituted for the original. When viewed with a LivePicture viewer, you get a lightweight, charming and completely effective interactive display. There is a freeware Java viewer available from www.livepicture.com

VRML viewers such as Cosmo are available for all the platforms of interest, but their capacity is not impressive. They seem to be suitable for small models, such as a single room, but not for the overall building. We are currently investigating various methods of generating radiosity lit VRML models of rooms where the quality of daylight is of interest.

2.4 Quake

Quake II is a bloodthirsty shoot-em-up computer game based on an extremely effective 3d rendering engine, which will run on most platforms, including Linux. A good deal of the game can be downloaded in source code, and both the scenery (‘levels’) and the 3D animated characters (‘monsters’) are replaceable, making the game something of an hacker’s delight but also something that we thought might be peculiarly appropriate for the Computer Lab web site.

*Figure 5.*The Computer Laboratory proposal in Quake II

There are around half a dozen shareware level editors for Quake; we chose one called Qoole, which with a CD of useful resources cost us $120. The runtime system is contained on the ordinary Quake II disc, around £30 from any games store. Qoole provides an object oriented modelling environment in which to construct the architecture of the set, texture it, and locate lights. If you are developing a game, you will also locate and parameterise monsters, weapons, sensors and all the apparatus of gameplay. When completed, the level is handed over to a three-stage compiler, which produces a playable level. The first stage constructs a BSP (binary space partition) tree, using the bounding planes of architectural objects to subdivide empty space into nested convex subspaces. The virtue of the BSP tree is that it can be traversed in priority order, as seen from any viewpoint, leading to a very fast rendering algorithm. The second stage appears to work out intervisibility between subspaces, creating chains of spaces that can be seen from a particular location, as an optimisation of the basic algorithm. Without this visibility information Quake II can still render a level, although at much lower frame rates. The third calculates the lighting, on the radiosity principle, exploiting the visibility calculations that have already taken place.

Compiling a level of any complexity requires considerable resources. We use our web-server, which has twin 333Mhz Pentium II processors and 256Mbyte of memory, and can compile the structure, shell and core of the building (no internal partitions) in about 4 hours. Using much less memory triggers an orgy of paging whilst calculating the visibility; with only 128Mb of memory, compiling does not complete in a weekend.

The level editor prefers orthogonal geometry, and a modular grid, which turns out to be based on the size of the texture tile. It is a little difficult to establish the scale at which you are working - the basic yardstick is the eye-height of the viewer which seems to be about 50 units. We standardised on 64 units being 2 metres. You do not get manuals with this sort of software; you have to learn by doing, or joining an internet discussion. One tip we picked up from an experienced level builder (who happened to be visiting the Computer Lab), was to flag lights and other elements which do not enclose space as ‘detail’ so that they are ignored in generating the BSP tree. Unfortunately, flagging the columns as ‘detail’ speeded up the BSP and visibility calculations to around 1.5 hours, but reduced the frame rates considerably.

Our first level took about 2 weeks to complete, mostly learning how to do it. It comprised the floors, roof, columns, external and core walls, staircases, and lifts. We omitted windows, partitions and furniture. Originally, we used a lurid science-fiction landscape from the original game as a backdrop to the building, but it proved simple to switch this to digicam shots of the surrounding buildings on the West Cambridge Site, combined with a painted sky. As at that point no architectural commitment had been made to materials and textures, we used texture tiles from the original game throughout. These are engaging in a grungy sort of way but obviously unreal, so the model is readily understood to be about the spatial arrangement of the building, not its surface appearance. The lighting compiler was set so that the sun shone from where it was painted on the sky and cast shadows. The interior lighting, based on skylight through the windows, reflected sunlight, and interior area sources, is excellent. This is global illumination calculated not for a room but for the complete interior, within a few hours, and with no more fuss than specifying the number of interreflections to be considered and a general ambient lighting level to stop totally black shadows.

Considered as a VR system, the Quake engine provides very fast software rendering and smooth movement, full screen (640x480) on a 250MHz PII, with clash detection and gravity. Cheap 3D hardware reduces the processor requirement considerably. Precomputed lighting gives a huge lift in architectural quality. Moving objects are easily programmed - we have doors that open on proximity, and a functional elevator. The controls are easy to use, with the mouse used to ‘look around’ and the keyboard to walk. Best of all, the model can be populated with as much ease as you can plant trees in a normal CAD environment. The people are admittedly rather ugly, and rather liable to shoot you unless programmed otherwise, but they move around, and start to define the architectural scale like nothing else can. If the game is switched to ‘deathmatch’ several people can join in each from his own workstation, and seeing the others in the guise of monsters. With a little attention to the ‘skins’ of these monsters, we shall soon be able to let Geoff Cohen (the architect, in London) conduct Bill Gates (the sponsor, in Seattle) on a virtual tour, watched by anyone who cares to join in. (Provided, that is, that they surrender their guns at the door).

3. ASSESSMENT

3.1 Management Issues

At the time of writing, the project has been running only six months of its allotted two year span, but we have already learned a great deal. We assumed when writing our proposal, that the project was about openness and communication, but discovered from day one, that it was just as much about privacy and control.

The situation was an unfamiliar one to all the participants (except perhaps Microsoft), and each member of the building Project Team, had its own quite proper reservations. The architect quite naturally, did not want to lose control of the process of issuing information, or of the appearance of what was released. So we agreed with RMJM that material would first be mounted on a private web site, and not released to anyone else until they had approved it. EMBS did not want to lose control over the overall process, so we agreed that material would not be made visible to the Computer Lab until the Project Team had decided that it was appropriate to release it for consultation. They were also concerned that we should not put an extra load on the architect which might cause a fee uplift. Everyone realised that feedback from the site would have to be managed in some way - the architect could not be expected to deal with hundreds of emails from all over the organisation. It was agreed that a co-ordinator (seconded from EMBS to the Computer Lab) would moderate the bulletin board, and pull together issues that ought to be addressed. In practice, major issues which have arisen on the web site have been discussed for a while, and then brought to a Project Team meeting, usually by the head of department.

In the end we proposed five levels of privacy for the web site, with carefully monitored transitions between them. In no case would the webmaster move material from one level to another without express instructions. The levels were:

a) Private to the Martin Centre and RMJM, for material under development
b) Private to the Martin Centre, and the Project Team.
c) Released for consultation, available to all members of the Computer Lab, University administration, and Microsoft.
d) Available to the whole University, and Microsoft
e) Available to the world

This structure is designed to reassure rather than for ease of administration, and has caused greater delays than we would like to the flow of information. We are hopeful that, as confidence grows, there will be some simplification.

The feedback bulletin board was initially conceived of as being available to the whole of the Computer Lab, staff and students, but this wide exposure was found to inhibit discussion. At the head of department’s request, a second inner discussion group of senior academic staff was established. Again, at the user’s request this is configured as an email listserve, rather than using web forms, and is backed up by a mail archive on a secure server in the Computer Laboratory so that membership of the group can be validated through their login id’s on the Computer Lab UNIX network, information not readily available to our web server. These changes have been effective in stimulating a much more directed and vigorous discussion.

Another case of privacy promoting discussion occurred when printed plans that were hung up on a publicly accessible whiteboard. They soon accumulated a variety of comments and redrawings, which we photographed and published. We offered to establish a webcam, to keep the whiteboard constantly in view. This was declined, on the basis that people wouldn’t add their suggestions if they thought that they were being watched.

3.2 Design issues

The usefulness of the site is best judged by the quality of the discussion it develops, and its influence on the building itself. The opening messages were not too encouraging - being about ladies' lavatories (Curiously the discussion on the parallel site at MIT opened on the same issue). Green principles were the first serious issue, to which we responded by posting a summary of the design principles involved on the 'Design Issues' pages. At that point RMJM were proposing a system of night-cooled hollow concrete slabs called 'termodeck', which was unfamiliar, and required some explanation. Eventually RMJM organised a visit to a similarly equipped building at the University of East Anglia (which then appeared on the "Reference Buildings" page), and the issue became quiescent. Later still, when they had measured the actual heat gains from computer equipment, they dropped this proposal in favour of 'chilled beam' cooling.

Provision for cyclists and catering have been continuing themes, perhaps not yet resolved to everybody's satisfaction. But the first major debate occurred when the Scheme 3 plans were released. This showed the building organised as a 'finger' plan; four ranges of research accommodation cross connected by a range containing the teaching and communal spaces, lecture halls and library. This was criticised on a number of grounds, such as difficulty of circulation for researchers, who would have to exit and reenter the secure areas to visit a lab in a different range, poor views out, overlooking from the lab opposite. The discussion culminated in a meeting, where the architect was encouraged to look at a courtyard alternative. In fact he looked at many more, which were not published, until Scheme 14 was reached, which had a figure-of-eight plan, with two courtyards. This dealt with the principle issues, and discussion moved on from the overall building form to detailed dispositions. Offices which were shown as 2 by 5 metres were felt to be too long and thin and were changed to a squarer form, a computer room was moved from the sunny south facade to the north, and the library which partly occupied a courtyard was relocated within a range.

Concerns have recently been raised about the wiring strategy, for both power and IT. This is receiving a good deal of design attention, and the issue for us is to find a way of publishing the result, so that everyone can see that it is resolved.

Lately, since the plan has settled, discussion has focused on the size of windows, which some feel are too small for adequate daylight, or views, or both. This is more difficult to resolve, as the window width is conditioned by the planning module, and the height by the structural system, though the interconnection between these issues has not surfaced until now. As usual, when a serious issue arises, the head of department has summarised the discussion to the architect, and asked him to consider it further. There the matter stands, at present.

3.3 Web site issues

We had some initial problems with comprehensibility of the DWF plans, where the vivid colours of the lines puzzled everybody. They appeared to be coding for materials, but enquiry revealed that they simply denoted the line thickness that would be used if the drawing was plotted. It is a point in favour of the PDF files that they show the lines as various thicknesses of black, as intended. The scale of drawings also puzzled people - although the structural grid spacing was dimensioned 6000, it was not appreciated that this signified a dimension in millimetres. During the discussion on windows, and on many other occasions, we would like to have been able to take measurements off the web plans and sections. None of the viewers allow for this elementary function. We also find the ability to print all or some of any drawing to be essential. It is a major drawback of the freeware Java DWF viewer that it does not allow for this.

On the 3d side, the Quake version has been widely appreciated, both by the Computer Lab and the architect. Significant suggestions for improving it include finding a way to label spaces, so you know which room, range and floor you are on, and provision of a keyplan for orientation, and possibly for 'jumping' your viewpoint.

A deeper problem has been raised by the Computer Lab. They have a growing archive of correspondence, reports and minutes of decisions, which they would like to hold electronically, in the form of a cross-referenced, indexed and searchable archive. We are currently considering how best to accommodate this.

Another issue for the future concerns the topology of our web site. At present it is a shallow tree, with large drawings or documents as the leaves. We envisage that eventually we will have multiple representations, such as plan, schedules and VR for many or possibly all rooms in the building. If these are fully cross-linked, the topology will become a dense mesh, which would be flying in the face of most web usability studies, which suggest that shallow trees are desirable for comprehensibility.

Finally, we must remark on the most fundamental of our tools, HTML. We started off using an editor (Adobe PageMill), in the hope that we could avoid coding HTML directly. This was rapidly found to be an illusion. Testing our pages in Netscape on Linux, PC and Macintosh, and Internet Explorer on the latter two, we found inconsistencies and failures that could only be disentangled by examining and modifying the HTML. From that, it was but a short step to composing HTML directly. We might still use an editor for the initial formatting of a complex table, but from then on it will be maintained by direct editing the HTML. And HTML itself is a monster. As a graphic design tool, it makes a point of failing to control layout and appearance, which is what a graphic designer cares about more than anything. As a language, it reeks of the bad old days, when the GOTO was considered essential and spaghetti code an art form. Its lack of defined semantics guarantees inconsistent implementation, an opportunity joyfully seized upon by the browser vendors and enlarged by their incompatible extensions. It defies modularisation and maintainability, lacking even the elementary notion of a subroutine. If there was ever a need for the standards organisations to save us consumers from the vendors, this is it.

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